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Heatwaves, cooling and young children at home: Integrating energy and health objectives

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ABSTRACT

This paper examines the practices advised by health authorities and performed by parents to cool infants during hot weather. The aim is to explore how health and energy efficiency imperatives can be better integrated for households. Consumption of home air conditioning is increasing around the world alongside policy concerns about energy poverty, climate change and peak demand. This paper analyses online sources containing advice to parents about temperature, hot weather and infant health. The content of this 'know-what' for parents was considered alongside experience-based 'know-how' (Royston, 2014) as described by parents in 44 interviews and home tours in Australia. Air conditioning is frequently positioned by health authorities as superior to low or no energy practices. However, understandings of infant care during hot weather are diverse and unsettled – both amongst parents and authorities. The absence of health sector consensus leaves space for energy policymakers to engage with the health sector to develop integrated cross-sectoral policy approaches. Continued circulation of adaptive, less energy-intensive hot weather practices is needed. Arresting the trajectory towards widespread reliance on air conditioning can help household finances, reduce electricity demand during hot weather, and avoid leaving parents ill-equipped when high demand or unexpected events compromise electricity supply.

1. Introduction

'We installed reverse cycle air conditioners...so we were keeping [our daughter's] room cooled all day'

'I think fresh air's the best thing, especially in children'

This paper addresses a pressing energy policy concern: how to tackle the apparent inconsistencies between health and energy policy imperatives for households while addressing concerns about infants' health during very hot weather. There is currently little integration between energy and health sector policies, which is a key problem in countries like Australia where extreme heat, housing and peak electricity demand are intimately linked [1]. Health authorities often advise using energy intensive mechanical/refrigerated cooling ('air conditioning') to mitigate adverse health impacts during heatwaves. However, many Australian households, particularly larger households with children, are struggling to pay energy bills [2,3]. As in many countries, Australian energy policy is committed to introducing higher prices for electricity used at peak times to 'signal' households to reduce use, particularly during periods of very hot weather when air conditioner use stretches the capacity of electricity infrastructure [4,5]. Parents currently need to navigate between energy sector messages

(reduce peak usage or pay higher bills) and health advice (use air conditioning because infants are vulnerable to heat), which sit alongside their own understandings and experiences about how to keep infants cool in hot weather. In addition, the energy sector appears reluctant to suggest households forgo air conditioning altogether which limits the scope for demand management.

In this paper we investigate health authorities' advice for parents of infants (0–2 years old) in hot weather – what Royston terms 'know-what'. We analyse this 'formal' advice alongside parents' 'know-how' for keeping infants cool [6]. Know-how refers to the experience-based knowledge, meanings and competences underlying the practices performed. Insights into how parents make sense of the perceived needs to keep their infants cool in hot weather are drawn from 44 in-home interviews with parents in Australia. We explore how heat health 'know-how' and 'know-what' both inform and compete with each other to produce outcomes that may be counterproductive for energy aims. The major contributions of this paper flow from the finding that even though many health authorities present air conditioning as superior for infant health in hot weather, the position of air conditioning (and its significant energy demand) is quietly contested both between health authorities and by parents who utilise significant know-how to perform low and no energy practices to care for infants in hot weather. By

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demonstrating that health authorities are not settled on air conditioning as the healthiest approach to hot weather, and by showcasing the diversity in parents' practices, our analysis highlights new opportunities to address peak electricity demand and household health in extreme heat. More broadly, this can also shift focus away from striving to meet ever expanding peak demand.

In the remainder of this paper we outline the importance of household air conditioning and other hot weather practices from both energy and health perspectives. We then present the conceptual framing and methodological approach for our analysis. The findings are presented in three sections before discussing the implications for energy policy.

2. Background

Space heating and cooling use accounts for up to 40% of household energy use in Australia and most use more energy for heating than cooling [7]. Home heating is widely accepted as essential for health and wellbeing in cool climates but the role of air conditioned cooling is not well understood. The prevalence of home air conditioning is rising with a further 700 million air conditioners predicted to be installed worldwide in the near future [8]. Increased consumption of air conditioning hinders efforts to reduce greenhouse gas emissions and contributes to climate change-associated extreme weather [9] – during which parents with and without access to air conditioning need to manage the impact of hot weather on infants.

In Australia, heatwaves have caused more deaths than any other extreme weather event [10]. Epidemiological studies have established that the elderly, people with particular health conditions, and babies and children up to around 2 years old (collectively referred to as infants in this paper) are most at risk of adverse health outcomes or death from heatwaves Refs. [11,12]. Infants have limited ability to regulate body temperature and can dehydrate rapidly during hot weather [13]. The limited capacity of infants to comprehend, communicate and attend to their physical needs adds to their vulnerability and dependence on parental care. Access to home air conditioning has been found to be a 'protective' factor for health during heatwaves and some concerned with population health impacts from heatwaves have called for increased access to air conditioning [14–17]. These findings predominantly relate to elderly and socially isolated adults but paediatricians have also advocated this approach [13]. However the World Health Organisation notes risks including increased energy use, equity of access, and risk of power failure during heatwaves [18].

Over the past 20 years, home air conditioning has transitioned from a luxury to almost standard item now present in three quarters of Australian homes [19]. Due to limited attention to energy efficient design and construction, home sizes, and appliance inefficiency, air conditioning Australian homes typically demands substantial electricity. Meeting rising peak demand has contributed to rapid increase in electricity prices and household financial stress [20]. The energy sector is committed to introducing 'cost-reflective' tariffs involving higher prices for electricity used at time of peak demand such as time-of-use, capacity tariffs and critical peak pricing 'signal' to encourage households to manage peak energy consumption [4]. These higher electricity price signals will usually apply during periods of extremely hot weather and therefore, using air conditioning will have financial impacts on households [21].

Prior to the rapid uptake of air conditioning in Australia, households relied on a range of low- or no energy 'adaptive' practices including utilising water and air movement to keep cool [22]. Existing research tells us little about whether changes in household hot weather practices over recent decades have impacted infant health outcomes. However, Wallenborn and Wilhite and others have warned that increasing standardisation of indoor climates (e.g. via use of air conditioning) risks driving a decline in know-how for adapting to temperature extremes [23,24]. As such it is imperative to understand the position of

authorities on use of air conditioning and other low or no energy 'adaptive' ways of caring for health. Together with understandings of the infant heat health practices performed by parents, these insights are needed to guide energy policy which both supports health and manages the risk of unaffordable energy bills for families.

Energy researchers have not previously tackled the specific issue of infant-related air conditioning consumption or how it may be approached in the context of energy efficiency or peak demand aims. This paper targets this gap and adds to a body of research which questions the trajectory towards greater reliance on air conditioning both in the home and in non-domestic buildings (e.g. [25–27]). It also builds on other research about the role that understandings of health, and caring for children, play in shaping household energy demand [28–31]. In interrogating the apparent non-negotiability of infant-related air conditioning consumption, and highlighting the role of health policy in energy demand, this paper also contributes to an emerging area of 'invisible energy policy' research which seeks to understand how energy demand is shaped by policies from other sectors whose primary concerns are apparently unrelated, e.g. the education or health sectors [32]. Our analysis builds on Royston's methodological approach to understand how different types of knowledges (formal and informal) contribute to household cooling practices and energy outcomes.

In the following section, we outline the conceptual and methodological approach followed to generate these insights for energy and health policy.

3. Know-what and know-how for infant cooling in hot weather

Royston [6] notes that the birth of children requires parents to perform new practices for infant care. Advice is provided in the many publications and websites to assist new parents, particularly for addressing cold weather concerns. Government health departments, hospitals and other health agencies, and parenting websites or forums also commonly provide information for parents about caring for infants in heatwaves. During a severe heatwave in Australia in 2014, the 'Better Health Channel' website produced by the Victorian state government recorded a 435% increase in traffic to information about child safety in hot weather [33]. Such examples point towards the seeming importance of what Royston terms 'know-what' – the kinds of formal or official advice provided by authorities and agencies.

Alongside these types of knowledge, Royston draws attention to 'know-how', the 'practical knowledge, as distinct from factual or theoretical knowledge' () householders draw on to make sense of what to do during weather that may be a risk to health. Previous qualitative research has also drawn attention to the 'folk understandings' [34] and 'practical knowledge' householders draw on to perform practices [35], including those involved in staying warm or cool. In theories of social practice, this know-how is commonly identified as the practical accomplishments, competences or skills which circulate amongst everyday practitioners to inform what makes sense for them to do [36,37]. It sits alongside the meanings and materials which are also employed in the performance of a practice [37].

In this paper we analyse the key messages in know-what promoted to parents by health authorities and others who provide health information. We also consider how this know-what complements or competes with parents' know-how for keep children cool in hot weather. It is important to acknowledge that know-what and know-how are not mutually exclusive, fixed categories. Factual, theoretical or authoritative know-what *can* become part of practical know-how but *does not necessarily* underpin it. In addition, official know-what can be derived from the practical know-how developed by practitioners, in this case parents – the relationship is not one-directional. Despite their mutually constitutive role, the two terms assist analysis of household practices by focusing attention the role of both official and unofficial understandings of how things are or should be done.

4. Methods

We analysed online know-what for parents caring for infants at home to identify the range of hot weather practices (including any engagement with the issue of energy use) which are recommended by health authorities¹ and other sources which parents may consult online. Although government health department-produced child health record booklets are issued to parents when they have a baby these do not include advice for keeping babies cool. Given the occasional nature of heatwaves and widespread access to the internet in Australia, concerned parents are likely to consult online sources of advice about infant health in hot weather. Readily available online advice for parents in Australia was sourced using the search terms ‘heatwave’, ‘heat stress’, ‘hot weather’, ‘temperature’, and ‘C/F’ combined with ‘baby’, ‘child (ren)’ and ‘infant’. These searches also yielded advice for cool weather from which relevant know-what relating to room/weather temperature was analysed.

We identified approximately 50 materials which focused on know-what for parents or households in temperature extremes. The materials were predominantly online health ‘factsheets’ or advice articles produced by governments, hospitals, professional health and health advisory groups, some of which are also distributed in hard copy form. Articles and other authoritative information from community organisations, parenting websites,² news and commercial entities advising the community about caring for health in extreme heat were also included. Most materials were from Australian sources but prominent advice from health authorities and others in the United States (US) and Europe were also included.

As formal or official advice, online know-what from health authorities is likely to reflect current medical opinion(s) and be broadly indicative of advice provided by health practitioners (e.g. doctors and maternal child health nurses) to parents of healthy infants. Pre-existing health scenarios which may increase infant heat vulnerability (e.g. diarrhoea, asthma, premature birth) would be more appropriately addressed in direct consultations with health professionals and any health condition-specific materials were excluded. The hot weather and temperature-related content was analysed thematically [38].

Parents³ know-how for hot weather was drawn from 44 face-to-face interviews conducted as part of the [removed for peer review] project. Interviews and a home tour (where feasible) were conducted with parents with children aged less than 18 years old living at home. Households lived in metropolitan and regional areas of the Australian states of Victoria and New South Wales, all areas which experience cool winters and variable summer temperatures including occasional periods of extreme heat.⁴ Participants were recruited via posters, paper and electronic flyers, email, a project website, social and other media with assistance from a range of organisations that provide services for families or were likely to have contact with parents. Households were offered an AU\$50 gift voucher for their participation to avoid a strong environmental or altruistic bias in the sample. Participants were mainly female (86%) as few fathers volunteered to be interviewed, possibly reflecting less time availability and/or engagement with the ‘practices which use energy in households with children’ as the study was described. Several participants were sole-parents.

The households included in the study had up to 7 children aged from 2 months through to adult children living with parents, and

included parents from a range of educational and work backgrounds. Fifteen households (34%) were classified as low-income. Interviews were semi-structured and conducted as an open-ended conversation between the researcher(s) and participant(s) and included the following topics: health and other family priorities; daily routines and routine disruptions including heatwaves; and energy issues and management. Not all households had infants at the time of the interview but parents’ recollections of practices for infants in hot weather were discussed. Audio recordings of the one to two hour interviews were professionally transcribed. Data were coded thematically for analysis using the NVivo qualitative data analysis program. In this paper we are specifically interested in the findings regarding parents’ know-how of keeping infants cool in hot weather. Further results and details about the research are available in the study reports [removed for peer review].

The following three sections analyse our findings in response to three research questions: What do health authorities advise parents caring for infants at home to do in extreme heat? What is the role of air conditioning in infant cooling practices? What else informs parents’ infant cooling practices and how does this shape energy outcomes? Exemplary quotes from interviews with parents are included verbatim, italicised and referenced with pseudonyms. Quotes from the online infant health materials are also italicised and referenced to websites via footnotes.

5. Air conditioning know-what for infants during hot weather

Health sector materials agree that healthy⁵ infants need additional monitoring and care during very hot weather – including that they should be protected from direct sun and ideally kept indoors. In Australia, advice such as ‘if you don’t have air-conditioning, go to a cool place such as a library, shopping centre, cinema or swimming pool’ from the national government health department are common and imply that a non-air conditioned home is unsuitable for infants in hot weather.⁶ Such statements assume that parents have the means to safely transport their infants and nearby access to such locations – potentially excluding households without an air conditioned car or public transport close to their home and regional households who live far from public amenities. Similarly, recommendations that parents take their children to homes of friends or family if their own homes are ‘very hot’ assume that vulnerable households know and can reach others with cooler houses to share.⁷ The examples above illustrate how many health authorities’ know-what implies that air conditioning is superior or preferable for hot weather – without assuming that all households have home air conditioning. Suggestions to seek air conditioning elsewhere usually occur alongside suggestions to participate in adaptive practices such as increasing frequency of infant feeds/fluids, reducing clothing, sponge bathing, or using fans sometimes in combination with wet fabric or mist of water, (as recommended by Kidsafe Child Accident Prevention Foundation Australia⁸). These suggestions are broadly based on the idea of cooling the body instead of the home. Where they occur alongside positioning of home air conditioning or air conditioned spaces as superior to hot homes, the low or no energy options appear as less adequate options.

Health authority advice from the US differs in key ways – it often explicitly states that air conditioning is needed, presents fans as inadequate, and suggests that the risk of heat for children is not limited to infants. For example, the Extreme Heat FAQ from the Centers for Disease Control and Prevention (CDC) notes ‘children up to four years of age’ as ‘at greatest risk’ and says, ‘electric fans may provide comfort, but

¹ We refer to health authorities as well known or regarded medical/health organisations, government agencies involved in health policy, and organisations supported or endorsed by government to provide health information to the public

² The advice shared between parents in forums associated with parenting websites was treated as know-how for the purpose of the analysis

³ References to ‘parents’ include step-parents, grandparents, legal guardians and others who look after children living in their home as per our study of households with children

⁴ The research does not cover tropical or consistently humid parts of Australia where a smaller proportion of Australians reside.

⁵ Advice may vary for chronically or acutely ill children.

⁶ <https://www.healthdirect.gov.au/hot-weather-risks-and-staying-cool>.

⁷ <http://www.health.nsw.gov.au/environment/beattheheat/Pages/babies-children-hot-weather.aspx>.

⁸ http://www.kidsafensw.org/imagesdb/wysiwyg/preventingheatrelatedillnessesinchildren2013_1.pdf.

when the temperature is in the high 90 s [approx. 36 °C], fans **will not prevent heat-related illness**'.⁹ The American Academy of Pediatrics primarily advises to 'plan to have a cool, air-conditioned space for your child'¹⁰; and this 'information for parents' about 'protecting children from extreme heat' does not target babies or infants specifically but instead presents all children as vulnerable and includes imagery of a school age child. Air conditioning is positioned as an essential material for keeping children cool. Hydration, cool baths and water mists are also suggested, but not fans. The difference in US advice relating to fan use is likely to be due to ongoing debate (not infant-specific) about fans and the possibility that they increase dehydration rates, but a Cochrane review concluded that no substantive evidence exists to refute or support this theory [39]. The World Health Organisation (WHO) Europe does not dismiss fans entirely, saying 'when the temperature is above 35 °C, [fans] **may not prevent heat-related illness**'.¹¹

In interviews, parents in Australia often recalled seeking know-what for hot weather online. Jane considered a range of sources, saying:

'I do remember sort of looking up that sort of stuff about what to dress, like what to dress him in at what temperatures...Raising Children's Network [a government and hospital-supported parenting website] was the main one I used...but I do tend to read other like forums for mums and things like that too.'

For Jane and other parents, know-what from health authorities and other sources was intertwined know-how derived from their own and other parents' experiences – resulting in a wide range of hot weather practices to care for infants. When Jane's baby was born the family lived in a home without air conditioning and she described her hot weather practices as 'more about whether he needed water...I remember giving him cold baths, like cool baths'. Jane experienced this low energy strategy of cooling her baby's body instead of the room as healthy and sufficient but when the family moved to a house with air conditioning she used it:

'Probably anything above 35[°C] with him because he was so little at the time I didn't generally go out on those days. So I was pretty much staying at home...I would run [the air conditioner] on those days'

For Jane, air conditioning was preferable but not essential. Experiences shared with another parent contributed to Carol's use of air conditioning for infant health:

'When she was a baby I actually turned on the air-con a bit more ... I actually notice[d] her nose actually bleed three times on a very hot day...I was talking to one of my friends and her daughter was having a nose bleed as well'.

Kelly did not have air conditioning prior to starting a family, but the family installed it and relied on it extensively after starting a family:

'We installed reverse cycle [heat pump] air conditioning so that we could heat [our daughter's] room and cool her room...our roof doesn't have insulation and it's very shallow, so the heat is just there...when she was a baby she was having three naps a day in that summertime period. So we were keeping her room cooled all day'.

Like Carol and Kelly, parents often linked their cooling know-how to what they 'felt' was best based on experiences of their home and their children's bodies.

Despite typically positioning air conditioning as superior for infant health in hot weather, most health authorities do not provide guidance on what temperatures may be a risk to infant health. Parents are largely left to make their own interpretation of what 'too hot' or 'very hot' for

infants means. The US CDC's fan-related reference (above) to 'high 90 s [approx. 36 °C]' and a state health department statement that 'when temperatures are hotter than 35 °C, your body may not be able to cool you down enough'¹²; are not infant specific and are ambiguous as to whether they are referring to indoor or outdoor temperatures – particularly as readers from different climates may interpret them differently. WHO has over recent decades investigated the evidence on indoor temperatures, advocated different ranges, and commented on insufficient data to develop indoor thermal parameters for housing with vulnerable occupants [40] – although these investigations were primarily concerned with protection from cold. The only clear guidance found was from WHO Europe which states, 'ideally, the room temperature should be kept below 32 °C during the day and 24 °C during the night. This is especially important for infants...'.¹³ This statement could be interpreted as a need for air conditioning in homes that reach this threshold however WHO Europe primarily promotes adaptive approaches to achieving this aim including 'use the night air to cool down your home' and 'turn off artificial lighting and as many electrical devices as possible' to reduce heat in the home. In the absence of temperature guidance in most hot weather advice, these materials are open to changing cultural interpretations relating to air conditioning.

In contrast, health sector know-what for parents on other topics is often quite specific – but not necessarily consistent – about temperature. 'Ideal' temperatures combined with a lack of distinction between health and comfort increase the scope for interpretation in hot weather. For example, a highly regarded public maternity hospital in Melbourne advises parents with crying babies that 'the room temperature in your baby's room should be around 18[°C]'.¹⁴ Taking into account the construction quality of Australia's housing and variable weather this advice could be interpreted as recommending cooling or heating (climate control) throughout the year. However, it appears that the above advice is written with cold weather in mind as the same hospital's 'Heatwave precautions for babies & young children' webpage advises parents with air conditioning to 'make sure the room does not get too cold (about 24–26 °C is low enough)'.¹⁵

Despite warnings about setting air conditioning too low for infant health, ideas of narrow defined temperature ranges for comfortable sleeping are also being integrated into hot weather know-what. Although it does not mention air conditioning, the National Health Service (NHS) in the UK advises in its 'How can I keep my baby safe during hot weather?' information that 'your baby will sleep most comfortably when their room is between 16 [°C] and 20 [°C]'.¹⁶ Such advice implies air conditioning is important for parents wanting their children to be comfortable and well slept (a priority for many parents), even in the UK where summer heat extremes are substantially cooler than parts of Australia and the US. Further complexity arises from Sudden Infant Death Syndrome (SIDS) advice which usually warns against making babies 'too hot' or 'overheated' via too much clothing or bedding (cold weather implied). SIDS authorities such as the Lullaby Trust in the UK prescribe specific room temperatures, including 16–20 °C¹⁷ but the SIDS and Kids National Scientific Group in Australia explicitly states that it 'does not recommend a specific room temperature for healthy babies' and that 'in Australia with the absence of very extreme temperatures it is usually not necessary to measure room temperature'. It advocates

¹² <http://www.sahealth.sa.gov.au/wps/wcm/connect/2e1d0880431be06eb42eff5fdb58e26/16107.1+Extreme+Heat+A5+Book%282016%29v4WebS.pdf?MOD=AJPERES&CACHEID=2e1d0880431be06eb42eff5fdb58e26>.

¹³ http://www.euro.who.int/_data/assets/pdf_file/0007/147265/Heat_information_sheet.pdf.

¹⁴ <https://www.thewomens.org.au/health-information/pregnancy-and-birth/at-home-with-your-baby/crying-baby/>.

¹⁵ <https://www.thewomens.org.au/health-information/pregnancy-and-birth/at-home-with-your-baby/heatwave-precautions-for-babies-young-children/>.

¹⁶ <http://www.nhs.uk/chq/Pages/1955.aspx?CategoryID=62>.

¹⁷ <https://www.lullabytrust.org.uk/roomtemperature>.

⁹ <https://www.cdc.gov/disasters/extremeheat/faq.html>.

¹⁰ <https://www.healthychildren.org/english/safety-prevention/at-home/pages/Protecting-Children-from-Extreme-Heat-Information-for-Parents.aspx>.

¹¹ http://www.euro.who.int/_data/assets/pdf_file/0007/147265/Heat_information_sheet.pdf.

monitoring and adjusting the temperature of the infant instead.¹⁸ The examples above demonstrate how infants' temperature 'needs' are unsettled in the health sector, and the ways protecting against health risks are not necessarily distinguished from 'ideal' temperatures for comfort and other purposes (e.g. good sleep).

However, we found that temperature recommendations in the 16–21 °C range are widely circulated including in heatwave news articles,¹⁹ parenting websites,²⁰ and marketing of nursery thermometers and air conditioning. The following example from an air conditioning company's website draws on health authority temperature advice to position air conditioning as essential for responsible parenting. Crown Power claims climate control creates a 'perfect environment' for children:

*'Since overheating is linked to SIDS, young children benefit from air conditioning being set cooler ... paediatricians recommend a temperature between 18 and 21 degrees as optimum for sound sleeping and protection against overheating.'*²¹

Some parents in our study monitored room temperature, for example Clare said, *'we've always had a [room temperature monitor] in his bedroom because obviously with babies you have to keep them at the right temperature'*. Parents mostly incorporated ideas of minimum temperatures such as 16 °C or 18 °C in their cold weather know-how indicating that they did engage to some extent with temperature know-what from health authorities or other sources. However, parents who did consider air conditioned cooling important for infants did not usually climate control the home and maintain the narrow range of temperatures suggested by some authorities above. Most used the air conditioning only on what they felt were 'very hot' days, or only when they 'really need it' instead of climate controlling the home. This points towards the role of practical and embodied experiences and other meanings involved with air conditioning use.

Health and comfort meanings blended together in parents' practices when relying on air conditioning. Infant behaviour and emotional state such as crying and irritability informed their hot weather practices. Jasmin spoke English as a second language and said the heat made her infants *'feel boring'* and *'impatient'*. The only air conditioner was in the master bedroom where *'during the very hot day, we let the kids to stay there, or sleep there'*. Part of the role of air conditioning in households with children was to manage the challenges of parenting by reducing parent and/or child discomfort. Briony said:

'When we were in Hazelbrook further down [where the weather is hotter] we definitely needed air conditioning, and it was like a sanity saver, because it's too hard to cope with the physical demands of parenting ... and then [the children] get crabby when they're too hot... a baby, and so they don't understand why they're crabby'.

Although Becky had *'used to just wet some sheets and put them on the cot and put the fan there'* when her sons were infants, she linked their current use of air conditioning to her sons' behaviour in hot weather saying:

'They're more lethargic and not more aggressive... quite angry I think because, and also they're kind of frustrated perhaps because they can't go outside and play...so they watch more TV or they just kind of stay in the air conditioned room and demand more Icy-Poles'.

A shift from being able to manage without air conditioning to 'reliance' was evident in many households. Peta regarded her young children as resilient to heat even when they experienced a 45 °C day saying *'The girls are just like "Yay, this is great". They're fine'*. However, the family installed solar with the understanding that it would secure

their access to air conditioning. Peta said:

'One of the reasons we got the solar [photovoltaic panels] so I can put [air conditioning] on and not worry that there might be a blackout or that we'd be relying on it and it would be really expensive'.

Lindy talked about growing up in Australia without any air conditioning and saying, *'the [children] don't tend to complain about [the heat]'* and *'I'm not bothered by [the heat]'* but *'my husband's Swedish he feels the heat terribly'*. Later in the interview she mentioned that *'in the last three years is when a house with air con throughout has become part of our lives'*. Despite not considering air conditioning a requirement for children's health it had become a necessity for this family of seven children through the practical experience of having it.

Even though hot weather practices involving air conditioning take precedence, either explicitly or implicitly, in some health advice and households with children, the issue is not settled. Conflict remains about when and how it should be used. Where air conditioning is advised there is division on whether and to what extent indoor temperatures should be moderated for infants. Further, households incorporate or reject this know-what into their know-how in relation to their children's behaviour and emotional state, available housing and appliances, understandings of comfort and health, their past experiences, and the dynamics present within the household. The following section illustrates that some health authorities do not promote air conditioning for infants and highlights the range of adaptive cooling know-how utilised by parents to care for infants that do not rely on air conditioning.

6. Adaptive hot weather practices as healthy options

The Australian state of Victoria, in which half of the interviews were conducted, has experienced severe heatwaves over recent years causing adverse health impacts and loss of life [33]. As a result governments, emergency agencies and health authorities have undertaken substantial planning with the aim of reducing impacts of future heatwaves. The Victorian state government health department suggests air conditioning used alongside other strategies, in its general hot weather know-what for the community, perhaps with particularly vulnerable elderly and chronically ill people in mind.²² This state's online 'Hot weather and child safety' advice does not mention air conditioning or air conditioned spaces. Parents are instead advised to *'let babies and young children sleep in the coolest room in the house'*, *'hang wet towels over chairs or windows to cool the air'* and *'use fans, but not directed at the child'*.²³ Similarly, the health department of South Australia omits air conditioning from infant-specific know-what. The general hot weather advice positions fans and air conditioners on an equal level of suitability with statements like, *'try to cool down with a fan or an air-conditioner'*.²⁴

Regardless of differences in government health authority positioning of air conditioning between the states in which interviewed households lived, parents' know-how was diverse in both locations and included many adaptive strategies that weren't reliant on home air conditioning. Jill was confident in her hot weather know-how without home air conditioning despite experiencing discomfort:

'I was very pregnant when we had the heatwave, so I must say that was a little bit uncomfortable... neighbours did lend me a fan because it was a little bit hard, and also that my [almost two year-old] daughter and at 40 degrees [C]'.

²² <https://www.betterhealth.vic.gov.au/heat>.

²³ <https://www.betterhealth.vic.gov.au/health/healthyliving/hot-weather-and-child-safety>.

²⁴ <http://www.sahealth.sa.gov.au/wps/wcm/connect/2e1d0880431be06eb42eff5fdb58e26/16107.1+Extreme+Heat+A5+Book%282016%29v4WebS.pdf?MOD=AJPERES&CACHEID=2e1d0880431be06eb42eff5fdb58e26>.

¹⁸ <http://sidsandkidswa.org/assets/info-statements/room-temperature.pdf>.

¹⁹ <http://www.bbc.com/news/uk-36846359>.

²⁰ <http://www.pregnancybirthbaby.org.au/babies-hot-in-weather>.

²¹ <http://www.crownpower.com.au/blog/advice-and-tips/nursery-air-conditioning-and-heating>.

Jill provided her daughter with access to water, *'she has a portable bathtub which I put it in the garden and fill it with water and let her play outside in the bath, like, keep herself cool'*. Helen's rejection of air conditioning for hot weather and adaptive know-how was linked to 'practice memories' from childhood [41]:

'Air conditioning] feels like it dries the air out. But I also don't like having a stuffy home without air flow, so I like to have all the windows open and have cross ventilation... We use spray bottles and we have ice in our water. Yeah. Cold face washer. All the old fashioned stuff.'

As noted in previous research [1], Amy's ideas of 'fresh air' as the healthier option informed her hot weather know-how: *'we can open the windows and use fresh air. I think fresh air's the best thing, especially in children'*. Based on past experience, Amy considered fans a 'safety hazard for children' drew on a range of ways to keep the family healthy:

'Cool shower and a cold drink...we just don't focus on how hot it is. We even go outside 'cause sometimes it's nice to be outside even if it's warm. Like on my little balcony... or otherwise go to the [the shopping centre]'.

The role of home air conditioning in parents' hot weather know-how ranged from reliance to rejection. Health was the central concern but understandings of what is healthy or a risk to health differed. There were indications that health authorities' know-what (and its inconsistencies) informs such understandings but the contribution of experience was especially clear. Lindy's (previous section) husband had grown up in a colder European climate and his hot weather discomfort in Australia demanded use of air conditioning which then became 'needed' by the whole family (above). Conversely, experience of hotter or more humid climates could make Australian heat more bearable and air conditioning unnecessary for the family. Hua explained:

'Guangzhou is big city and it's really humid city. Normally we use air conditioner in the summer [in China] but when we came to Australia we didn't use [air conditioning]... Yes, this hot but the different hot, you know? In Guangzhou it's humid'.

The different types of know-how involved in practices performed by parents for hot weather in Australia were not explained by differences in climate, housing quality or tenure (i.e. access to air conditioning). Some parents who did not air condition for children lived in poorly designed and insulated housing in areas which often experienced extremely hot weather. Instead, understandings of hot weather as risky or sufficiently uncomfortable to demand air conditioning were often informed by experience and practice memories which can contribute to hot weather know-how that meets parents' health aims without air conditioning reliance. Some parents lived in regional areas and did not engage with health know-what advising that children be kept indoors. Drawing on childhood practice memories they enjoyed taking their children to local reservoirs or rivers during extreme heat. This draws attention to the ways that health know-what suggesting shopping centres and libraries can be 'city-centric', is limited by the opening hours of such places, and can be dismissive of other potentially healthy alternatives to air conditioning.

Many of the study participants, and particularly older parents, had grown up without air conditioning and recalled low or no energy ways to manage in the heat. The adaptive hot weather know-how from practice memories was available – even if the required materials to utilise this know-how (e.g. fans) were no longer present in the home after air conditioning became central to hot weather know-how. Wallenborn and Wilhite [24] warn that increasing standardisation of indoor climates (e.g. via use of air conditioning) risks driving a decline in know-how for adapting to temperature, which could be disadvantageous to health. Thinking of infant health specifically, it remains to be seen whether children raised in air conditioned homes have less low or no energy to fall back on when air conditioning is not available, e.g. due to financial hardship or electricity outages, when caring for their own infants in the future.

7. What about electricity consumption?

On the whole, hot weather health advice did not explicitly engage with the issue of electricity cost or distinguish between more or less energy efficient care strategies. Even where fans were recommended alongside the use of air conditioning, the comparably much smaller cost of running fans was not advised. Suggestions such as *'make sure the room does not get too cold, 24–26 degrees Celsius is low enough'* were made on the basis of health, not energy efficiency.²⁵ The promotion of 'ideal' temperatures implies that responsible parents should use mechanical cooling (and heating) and there are implicit assumptions that parents have the means to pay and also that supply will be readily available.

Understandably, the primary focus for health authorities is health outcomes. However, cost and accessibility of energy is rapidly becoming a much larger and more widespread factor in household health and wellbeing. In Australia and other countries, households are increasing going without wellbeing essentials and are experiencing adverse health impacts from energy-related deprivation and financial stress [20,42,43]. In this context, health advice will have better outcomes if it takes into account how the advice may play out in financially constrained households. Health authorities which do not prescribe air conditioning (Section 6 above) may already be doing this and are demonstrating how the health advice can take pressing energy issues into account without explicitly introducing energy advice into their communications.

The only health sector advice identified which was demonstrated concern about energy implications in heatwaves was from WHO Europe. This source did not preference air conditioning (see earlier). In saying *'if your residence is air conditioned, close the doors and windows and conserve electricity not needed to keep you cool, to ensure that power remains available and reduce the chance of a community-wide outage'*²⁶ WHO Europe refers to the contribution of air conditioning consumption to hot weather electricity outages. Although the costs of running air conditioning for households or the environment are not mentioned, WHO suggests constructive ways to reduce energy use and alludes to the idea that individual household practices can impact the broader community. This is a rare example of heat health advice considering public health on a larger than individual scale although there are examples of the health sector taking this approach on other issues, e.g. consumption of antibiotics [30]. WHO reports indicate concerns for equity and environment in their position on air conditioning for generally, e.g. [18]. WHO's indoor temperature guidance *'below 32 °C during the day'* positions air conditioning as far less widely needed than much other health advice. It is also a much higher threshold than suggested in advice about thermostat settings provided in energy efficiency know-what. No parents in our study mentioned being aware of or using the 32 °C indoor temperature advice. Although parents did not necessarily engage directly with health sector know-what for hot weather, and readily rejected aspects which did not fit with their practical experience, standardised advice (albeit perhaps with the most heat vulnerable scenarios in mind) which preferences air conditioning can contribute to the emerging cultural convention of air conditioning (and associated energy use) as essential – even to families who are well-equipped to manage health in less energy intensive ways.

Most households interviewed were concerned about household energy bill costs and wanted to use less electricity [removed for peer review]. While most could afford to pay these bills, some were experiencing financial stress and payment difficulties. However, the involvement of air conditioning in their hot weather practices was rarely informed by electricity cost concerns. The health of their family

²⁵ <http://www.health.nsw.gov.au/environment/beattheheat/Pages/babies-children-hot-weather.aspx>.

²⁶ http://www.euro.who.int/_data/assets/pdf_file/0007/147265/Heat_information_sheet.pdf.

was primary even though parents' understandings of how best to achieve this differed. As Helen (previous section) said, *'we don't actually like air conditioning so it's not necessarily about the cost'*. Parents often struggled to integrate health know-how with know-what for reducing energy bills. This may be attributed in part to the almost complete separation of health and energy considerations in the formal health know-what (as discussed above).

Parents' perceptions of air conditioning as unnecessary were not limited to low-income households and there was no evidence of unhealthy self-rationing of cooling or heating in the households interviewed but this has been found in studies of vulnerable households in Australia (e.g. [20]). Some households however were experiencing difficulties paying energy bills since having children. Kelly installed air conditioning specifically to cool her baby (see earlier) and said *'only since we have children and had to start to manage our finances so tightly'*. The family often negotiated extensions and payment plans to avoid being electricity disconnection. Sandi and Jack were a young couple with three year- and 10 month-old children using air conditioning in a large home which they were having to sell because of electricity bills and other debts. They were participating in an energy retailer hardship program and were hoping to rent a small home after their house sold. Sandi said, *'all of a sudden it feels like we blinked our eyes and we just don't know what happened'*. These examples highlight the broader vulnerability of families who consider air conditioning necessary and lack or doubt know-how for less energy intensive ways to care for infants in hot weather.

Other than occasional parent-to-parent discussion on forums, the only advice identified that explicitly engaged both with parents' infant health and energy aims came from a community energy efficiency initiatives. Such advice is most likely only found if parents' explicitly seek energy efficiency information in conjunction with health advice – it is not easily found and not heatwave-specific. The Energy for Babies kit is produced by Moreland Energy Foundation, a not for profit organisation in Australia which works with communities to reduce greenhouse gas emissions [44]. The publication highlights passive measures to regulate home temperature and efficiency of heating systems. However, it also deferred to conventional health advice by not challenging recommendations of 'ideal' room temperatures of 18–20 °C for babies. Instead it draws on this range to demonstrate that there is no need to use more energy turning *heating* thermostats higher. As ideas of narrow temperature ranges being needed for health transition from know-what to know-how, attempts to shift households towards less energy intensive practices will have even less impact.

8. Discussion

Table 1 summarises the findings from our research discussed above. This analysis illustrates diversity and overlap in health authorities' know-what and the know-how involved in hot weather practices performed to cool infants in hot weather. Despite indications of convergence towards use of air conditioning, hot weather practices for infant health remain in flux. These findings have several implications and present opportunities for energy policy (see Table 2).

Firstly, our analysis finds that Hitchings et al. (2015)'s interpretation of cold weather health indoor temperature range recommendations made by authorities as *'implicitly endors[ing] the idea that Australians lack the capacity to handle colder domestic conditions'* ([49], p. 162) also applies to hot weather know-what which preferences the use of air conditioning. Assuming that air conditioning is essential in young, healthy households narrows the path to address issues of peak demand and electricity bill affordability. Many authorities recommend (and parents often prefer) air conditioning, but parents also understand and employ know-how which prioritises water, air movement and active management of features of the home to reduce heat. These low or no energy approaches can be considered a legitimate form of 'knowledge' that informs formal 'know-what' and helps shift the positioning of air

Table 1
Summary of findings.

Findings
<ul style="list-style-type: none"> Health sector materials agree that infants need additional monitoring and care during very hot weather but diverge on the role of air conditioning, including: <ul style="list-style-type: none"> Explicit positioning of air conditioning as necessary Implication that air conditioning is superior or preferable Promotion of low-/no energy care practices without mention of air conditioning Health authority know-what tends to be non-specific or ambiguous about room temperature and infant health in hot weather (other than advising that air conditioning is not set too cool) Cold weather health advice prescribing specific or ideal room temperatures gets incorporated into hot weather know-what in unintended ways Parents' understandings of the best way to care for infants in hot weather: <ul style="list-style-type: none"> range from low-/no energy practices of cooling a child's body (without air conditioning), through to air conditioned space cooling as a necessity are shaped by health authority know-what, experiential and shared know-how, housing, and availability of home air conditioning can be affected by cold weather temperature recommendations do not necessarily delineate between health and comfort can contribute to financial stress Hot weather health advice rarely engages with issues of energy cost, efficiency or security

Table 2
Implications for energy (and health) policy.

Implications
<ul style="list-style-type: none"> Assumptions that air conditioning is essential in young, healthy households inform and limit strategies to address issues of energy demand and electricity affordability Promoting (explicitly or implicitly) air conditioning and narrow temperature ranges as necessary/safe for infant health in hot weather raises equity issues and other risks, e.g.: <ul style="list-style-type: none"> lack of access to home air conditioning due to financial constraints and/or housing tenure reliance on air conditioning can exacerbate energy poverty/financial stress households may become less equipped to care for infants in low-/no energy ways including during an extended electricity outage The energy sector needs to engage more explicitly with 'non-energy policies' such as those concerning health, and could benefit from cross-sectoral consultation and planning on the issue of peak demand and vulnerability in hot weather A broader view of health and wellbeing, demand management and mitigation of climate change should ensure low-/no energy ways to care for infants in hot weather are not replaced by reliance on home air conditioning

conditioning from superior or essential to one option from a range of hot weather coping strategies. The energy sector can go further than suggesting households make small changes in air conditioner thermostat settings to reduce their peak consumption and electricity costs. For example, initiatives which encourage and support households to avoid installation or use of air conditioning (including improving the energy efficiency of housing) should get more consideration. Drawing on the examples from health authorities that do not preference air conditioning, low or no energy ways to stay cool could be deliberately positioned as equally legitimate hot weather health know-how.

Inconsistencies and ambiguities in health authority advice know-what for hot weather suggest there is insufficient medical evidence to achieve consensus about whether widespread use of home air conditioning is the healthiest approach to caring for infants during hot weather. Our findings demonstrate that hot weather advice for infant health is interpretative, and reflects changing conventions and trends in thermal comfort e.g. [25,27]. The ambiguities and inconsistencies indicate that narrow temperature ranges and reliance on air conditioning may not be necessary for infant health if parents have the know-how for adaptive practices.

Secondly, while some authorities may consider air conditioning as

‘safest’ this approach raises equity issues and other risks. Families may be less well equipped to deal with hot weather because they live in poor quality housing which heats up quickly and has limited ventilation. However, many of these households are unable to access air conditioning for several reasons. Households may not be able to afford to install or run air conditioning [20]. In addition, a lack of minimum standards for rental properties and restrictions on tenants’ rights often prevent those living in rental properties from accessing energy efficient housing, implementing energy efficiency improvements, or installing air conditioning [52,54].

Promoting reliance on moderating room temperatures contributes to cultural conventions of air conditioning as essential and over the longer term diminishes know-how for other ways to protect the health of infants and the broader community. Given the way home air conditioning can become ‘needed’ once experienced, households who install air conditioning specifically for infant health will likely continue using it after children pass the heat vulnerable stage of life – contributing to ongoing costs for households and entrenchment of air conditioning. Alongside the financial impacts for families, replacing low or no energy hot weather know-how with reliance on air conditioning increases the risk that electricity infrastructure will be unable to meet demand or fail. In Australia, bushfires also threaten electricity supply during extreme heat [48,50] and in 2016 an unprecedented tornado toppled high voltage transmission towers causing a state-wide electricity outage which lasted several days in some areas (albeit in cold weather).

We can only speculate about why some health authorities in Australia exclude or do not preference air conditioning over adaptive approaches to infant health. Air conditioning may be viewed as a reliable way to protect health on an individual basis but these authorities may take a broader public health view which considers the above-mentioned energy security, health, financial and/or equity issues. The potential for reliance on air conditioning to hinder climate change mitigation efforts [45] may also be a factor in health authority know-what which presents low and not energy cooling as adequate and healthy. Prudent, risk-averse and equitable policy should account for wider and longer term risks to health.

This paper illustrates that parents’ understandings of how best to care for their infants are not based on understandings of energy and associated costs, or linked to a behavioural type or population segment such as ‘cost-conscious’ or ‘environmentally motivated’ (e.g. [51]). As described by [53], energy consumption is an outcome of having participated in a practice rather than a conscious decision or continually reflective process based on energy concerns. This observation is especially relevant in households caring for infants in hot weather. Diverse meanings of health and wellbeing consistently took precedence in parents’ hot weather practices for infants. These findings provide new insight into why energy policy and pricing strategies to reduce household energy use at times of peak demand, and more generally, are likely to have limited impact. Past research has demonstrated the improved impact of energy demand management initiatives which engage parents with ideas of health outcomes for children [47]. To intervene in practices such as cooling (and heating) with the aim of reducing household energy use, or arrest a trajectory towards higher peak consumption, the energy sector will need to engage more explicitly with expectations and assumptions of health in relation to hot weather practices for infants. For parents, the introduction of cost-reflective tariffs involving increased the costs for electricity used during hot weather in Australia and beyond, present a further financial challenge for air conditioning-reliant households.

Finally, effective and equitable energy policy requires greater engagement with the health sector, including on the issue of household health in heatwaves. Currently neither health authorities nor the energy sector explicitly engage with *both* households immediate concerns about health in heatwaves and the implications of hot weather know-how on energy bills. The positioning of air conditioning by some health

authorities indicates little if any engagement with household financial vulnerabilities or the risk of electricity outages. Further promotion of reliance on air conditioning will also undermine energy sector strategies to smooth household electricity demand. There is a pressing need for energy and health sectors to work together towards integrated strategies which address both short and longer term financial vulnerabilities and the potentially devastating consequences of prolonged electricity outages during extreme heat. There are certainly challenges to such cross-sectoral policy work, particularly given that much of the energy sector is privatised and health is predominantly a public service. However there are many precedents of collaboration between public and private sectors on shared concerns, for example adapting to climate change [46]. Increasing peak demand is a threat to both sectors: the electricity sector wants to deliver reliable supply and avoid the feared ‘energy market death spiral’ [3]; and the health sector wants minimal health impacts on vulnerable householders during hot weather, including in the event of an electricity outage. Government activities to plan for such events already involve both the energy and health sectors and can facilitate ongoing relationships and policy development which focuses on prevention. An essential part of an integrated strategy is to commit to supporting continued circulation of low and no energy know-how for hot weather in the community so that households have a wider range of hot weather know-how for dealing with future scenarios.

We note that the distinction between know-what and know-how used in this analysis is not clear cut. Parents may consider health authority know-what but their hot weather know-how is also informed by interpretation and their own and others’ practical experience. News and marketing articles authoritatively quote content from health authorities, and were treated as know-what in our analysis, but can include their own interpretations. Parents may regard such advice as no less ‘authoritative’ that provided by governments and health organisations. Online forums were treated as a source of experience-based know-how from other parents in our analysis but through this medium and publishing on the web, this shared advice can become a form of ‘know-what’. Our study did not establish the extent to which parents relied on health authority know-what compared to other sources of know-what or know-how but the analytical framing illustrated that each are important and how better acknowledgement of experience-based know-how can assist in devising energy policy which both addresses energy sector issues and supports health vulnerabilities.

9. Conclusion

This paper has highlighted the diversity of health authority know-what and parent know-how regarding hot weather practices for infants in the context of other risks arising from a trajectory towards greater reliance on air conditioning. If air conditioning was formally established as the ‘healthiest’ approach on a community-wide scale, then subjugation of energy in advice for hot weather and energy efficiency could be warranted. However, if it is not widely essential for infant health as the lack of consensus in health authority advice suggests, superior positioning of air conditioning in health and energy sector communications is questionable from both health and equity perspectives. Our analysis can embolden the energy sector in engagement with the health sector to explore ideas of air conditioning as *not necessarily* essential and ways to encourage the circulation of low and no energy hot weather practices which serve both individual and broader aims of health and wellbeing in the community. There is a clear opportunity for health and energy sectors to work together to integrate health and energy aims in hot weather health advice, energy efficiency programs and energy pricing and policy. Strategies that prioritise different forms of health and comfort and support lower energy hot weather practices are needed including circulation of materials such as water misters and fans. Looking beyond the energy and health sectors, policy which delivers improved housing and appliance efficiency, alongside access to renewable and affordable energy, is also needed to address the issue of

health and financial vulnerability in hot weather.

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